CH302H – Principles of Chemistry II: Honors
Spring 2014, Unique 51880

Quiz 5
17 April 2014

Natural strontium is non-radioactive, but ^{90}Sr, which is a byproduct of nuclear fission, is radioactive and undergoes a first order decay to ^{90}Y (β^- and gamma ray) with a half-life of 28.8 years.

a) What is the rate constant for this decay?

b) You monitor the radioactivity level of a sample containing ^{90}Sr over a long period of time. Sketch the plot that would result. (Use radioactivity level for y axis, time(years) for x going from 0 to 50 yrs).

c) How long for 90% of ^{90}Sr to decay after it was created by a nuclear fission event?

BONUS!!

d) This is a biological concern since Sr is incorporated in bones since it has similar chemistry to Ca. The ^{90}Sr radioisotope can cause cancer in some instances. It is estimated that the half-life of Sr in the human body is ca. 18 years. What percent of ^{90}Sr would be left in the body 25 years after an initial exposure to the material?

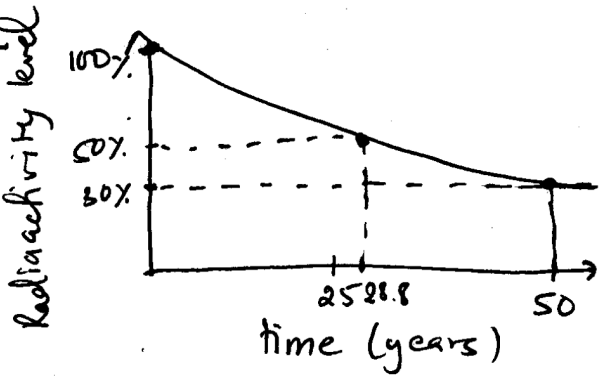
(a) First-order decay.

$$t_{1/2} = \frac{\ln 2}{k}$$

$$k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{28.8\ \text{yrs}} = \boxed{0.0241\ \text{yr}^{-1}}$$

(b)

t	% of ^{90}Sr
0	100%
28.8 yrs	50 %
50 yrs	30%



(c)

$$[Sr] = [Sr]_0 \exp(-kt)$$

$$10\% = 100\% \exp(-0.0241\ \text{yr}^{-1} \times t)$$

$$\ln(0.1) = -0.0241\ \text{yr}^{-1} \times t$$

$$t = \boxed{95.7\ \text{years}}$$

(d) Again assume first order decay of ^{90}Sr inside our body.

$$t_{1/2} = 18\ \text{yrs}$$

$$k = \frac{\ln 2}{t_{1/2}} = 0.0385\ \text{yr}^{-1}$$

$$[Sr] = [Sr]_0 \exp(-kt)$$

$$\frac{[Sr]}{[Sr]_0} = \exp(-0.0385\ \text{yr}^{-1} \times 25\ \text{yrs})$$

$$\frac{[Sr]}{[Sr]_0} = 0.3819 \times 100\% = \boxed{38.2\%}\ \text{remains}$$